CLAIMS

1. Method for determination of stand attributes by means of a laser scanner and images, in which a point cloud with three-dimensional information about the target points and describing the stand is produced by means of a laser scanner, c h a r a c t e r i z e d in that

a) overlapping images are produced by aerial or terrestrial photography,

b) a denser point cloud with more target points with three-dimensional information is produced by densifying the point cloud produced by the laser scanner with information from the overlapping images produced by the aerial or terrestrial photography,

c) the stand attributes are determined by means of the densified point cloud.

2. Method of claim 1, c h a r a c t e r i z e d in that after step a), the point cloud produced by laser scanning and the image information are combined to belong to the same target.

3. Method of claim 1, c h a r a c t e r i z e d in that the three-dimensional information of the point cloud produced by means of a laser scanner is formed of three-dimensional coordinates for the target points.

4. Method of claims 1 - 3, c h a r a c t e r i z e d in that for step c), the points measured from the surface of the terrain and the points measured above the surface of the terrain are distinguished from the point cloud produced by laser scanning, and three-dimensional points are added close to those points that are produced by a laser scanner and that correspond to points measured above the surface of the terrain.

5. Method of claims 1 - 4, c h a r a c t e r i z e d in that in order to determine three-dimensional coordinated for the target points the data achieved from the laser measurements and the image information of the aerial photography are calculated into the same coordination system.

6. Method of claims 1 - 5, c h a r a c t e r i z e d in that in step b), the three-dimensional target coordinates of the additional points are determined from the overlapping images produced by aerial photography by means of photogrammetric methods.

7. Method of any of claims 1 - 6, c h a r a c t e r i z e d in that step c) is performed by means of a pattern recognition method, by determination of models describing the crowns of the stand and the terrain, or by means of coordinate information.

8. Method of any of claims 1 - 7, c h a r a c t e r i z e d in that such a number of target points is applied that individual trees and groups of trees are discriminated.

9. Method of any of claims 1 - 8, c h a r a c t e r i z e d in that in step a), brightness values are produced for the points in addition to the three-dimensional coordinates by means of a camera or spectrometry.

10. Method of any of claims 1 - 9, c h a r a c t e r i z e d in that the laser scanner material used for the creation of a denser point cloud has several pulses modes or profile data (full waveform data).

11. Method of any of claims 1 -10, c h a r a c t e r i z e d in that a three-dimensional presentation of the stand height (canopy height model) is achieved by calculating, from the denser point cloud, the difference between a crown model corresponding to the upper parts of the stand and a digital terrain model corresponding to the surface of the terrain.

12. Method of any of claims 1 -11, c h a r a c t e r i z e d in that an anisotropy correction for the brightness values of an image is done for individual trees or groups of trees by means of the denser point cloud by using a crown model created by means of the denser point cloud.

13. Method of any of claims 1 -12, c h a r a c t e r i z e d in that a change in the stand can be calculated by means of denser point clouds or by means of

surface models corresponding to them achieved at two different time points, the change consisting of for instance a height or breadth growth, thinnings and fallen trees.

14. Method of any of claims 1 -13, c h a r a c t e r i z e d in that the identification of individual trees or groups of trees (determination of location or crown contours) is done by using the denser point cloud, the height model, surface models, intensity data of the laser scanning, profile data and/or brightness values of the images by means of a known pattern recognition method.

15. Method of any of claims 1 -14, c h a r a c t e r i z e d in that the identification of individual trees or groups of trees (position or contour) takes place by using images and the height for a desired tree is achieved by means of denser point cloud material.

16. Method of any of claims 1 -15, c h a r a c t e r i z e d in that old inventory information, earlier images and/or laser materials is used for evaluation or updating of stand attributes.

17. Method of any of claims 1 -16, c h a r a c t e r i z e d in that the tree geometry and/or the delineation of the tree is determined by means of sample points achieved inside the area restricted by the tree either two-dimensionally (cross-section) or three-dimensionally in order to identify the tree species or for modeling of the stand.

18. Method of any of claims 1 -17, c h a r a c t e r i z e d in that the attributes of individual trees or groups of trees, which are achieved by analyzing the canopy height model, are the location of the trees, age, height, crown diameter, crown delineation, stem diameter, quality of timber wood, tree value, basal area, crown closure percentage, development class, tree species, stem volume, and/or stem number per area unit and statistical attributes that can be derived by means of this information.

19. Method of any of claims 1 -18, c h a r a c t e r i z e d in that the stem diameter of the tree can be derived by means of the mean diameter of the crown or the tree height and the mean diameter of the crown and possibly by making use of rules based on knowledge and possible for each tree species separately.

20. Method of claim 18, c h a r a c t e r i z e d in that the stem number is determined as a number of crowns determined form a image or point cloud.

21. Method of any of claims 1 -18, c h a r a c t e r i z e d in that the crown coverage percentage is defined as the relation between the area covered by the crowns and the whole surface.

22. Method of any of claims 1 -21, c h a r a c t e r i z e d in that in addition to attributes of individual trees of groups of trees and statistical data for these, also a stem number and the crown coverage percentage of a stand that can be seen from above, are defined for a larger tree group, and this information can be used in the estimation of attributes for sample plots and stands.

23. Method of any of claims 1 -22, c h a r a c t e r i z e d in that the stand volume is completely or partly defined by means of the mean height of the stand and the crown coverage percentage, (the crown part of the total area)/ basal area.

24. Method of any of claims 1 -23, c h a r a c t e r i z e d in that the definition of stand attributes is performed by means of a computer program.

25. Computer program for the determination of stand attributes from information achieved by means of a laser scanner and images and in which there is produced a point cloud with three-dimensional information about the target points and describing the stand, c h a r a c t e r i z e d in that with the program,

a) there is produced a denser point cloud with more target points and three-dimensional information by densifying the point cloud produced by the laser scanner with information from overlapping images produced by aerial photography,

b) the stand attributes are determined by means of the denser point cloud.

26. Computer program of claim 25; c h a r a c t e r i z e d in that it performs the method of any of claims 2 – 24.

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